Remarks

Claims 29, 30, 32-39, 41-45, 48-51, 55-57, and 59-66 are pending in the above-referenced patent application and have been rejected. Claims 29, 49 and 59 have been amended. No new matter has been added.

The Examiner has rejected claims 29, 30, 32-35, 39, 41,48-51, and 60-66 under 35 U.S.C. §103(a) as being unpatentable over United States Patent No. 5,888,272 to Prasad et al. (hereinafter "Prasad") in view of United States Patent No. 6,505,567 to Anderson et al. (hereinafter "Anderson").

Prasad is directed to:

> "A process for separating a feed gas stream into an oxygen-enriched gas stream which is used in a combustor and an oxygen-depleted gas stream. The feed gas stream is compressed, and oxygen is separated from the compressed feed gas stream using an ion transport module including an ion transport membrane having a retentate side and a permeate side. The permeate side of the ion transport membrane is purged with at least a portion of a combustion product gas stream obtained from the combustion in the combustor of the gas stream exiting the permeate side of the ion transport module." (See the "ABSTACT" in Prasad).

In the Office Action, the Examiner states that "Prasad discloses the integration of an ion transport membrane- combustion module into a furnace atmosphere that is clean so as to form a single unit so as to create a heated oxygen which is directed into the furnace (firebox) to aid in combustion." In support of this characterization, the Examiner cites column 15, lines 15-25 of Prasad. Column 15, lines 15-25 read as follows:

> "It is also possible to integrate ion transport-combuster module with an internal circulation of the flue (furnace) gas. If the furnace and the ion transport-combuster module operate at about the same temperature (for example, between 800° -1200° C.), then the ion transport-combuster module can be placed directly inside the furnace provided that the furnace atmosphere is "clean", that is, it does not contain any species detrimental to the ion transport membrane. One way of implementing this idea is

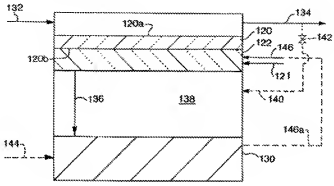
shown in FIG. 4 in which the ion transport process, combuster, and downstream process are all integrated in a single unit."

Fig. 4 of Prasad is reproduced below for convenience. Continuing the explanation of the system cited above by the Examiner, Prasad at column 15, further states that; "In this configuration, fuel gas stream 121 is fed close to the surface of permeate side 120b thus sweeping away and/or efficiently consuming oxygen transported across ion transport membrane 120." Prasad further recites:

> "Feed stream 132 such as heated air is directed against cathode side 120a of membrane 120 to produce hot, oxygen-depleted retentate 134 such as nitrogen. Downstream process 130 (for example, a furnace load) is shown on the permeate or anode side 120b of ion transport membrane 120. In this configuration, fuel gas stream 121 is fed close to the surface of permeate side 120b, thus sweeping away and/or efficiently consuming oxygen transported across ion transport membrane 120. The combustion products in hot zone 138 could be recirculated in the furnace against anode side 120b by natural or forced convection; for the construction shown in FIG. 4, combustion products stream 146, preferably obtained from furnace 130 as shown in phantom by stream 146a, and the fuel gas stream 121 are optionally fed through porous fuel distributor layer 122 adjacent to permeate side 120b of ion transport membrane 120. Preferably, distributor layer 122 defines at least one passage or chamber to more uniformly distribute fuel across the membrane 120." (See Prasad Col. 15, ll25-32).

Unlike the invention recited in amended claim 29 of the instant patent application, Prasad

FIG. 4



Does not teach or suggest a circulating fluidized bed boiler having an oxygen transport membrane disposed in the fluidized bed, wherein at least a portion of the heated solids contact the oxygen transport membrane transferring heat thereto such that the oxygen transport membrane extracts oxygen from pressurized air provided thereto for combustion in the fire box. Moreover, Prasad does not teach or suggest, as is set forth in amended claim 29, that the heated solids flow over outer walls defined by the membrane removing oxygen therefrom.

Instead, Prasad teaches that the membranes must be installed in a clean environment, with "clean" being defined as an atmosphere that does not contain any species detrimental to the ion transport membrane. Clearly, both the disclosure of Prasad set forth above, as well as the embodiment illustrated in FIG. 4 contemplate a "clean" environment as being one wherein the membranes are exposed only to gas streams and not put in direct contact with, as is claimed in the present application, hot solids. In fact Prasad teaches away from this by insuring that the membranes are positioned away from the furnace and that combustion products are fed through a porous fuel distributor layer 122. Clearly, the presence of hot solids in the combustion products would clog the pores in the fuel distributer.

Since Prasad does not teach or suggest hot solids coming into contact with the membranes, it follows that Prasad cannot teach or suggest that the heated solids flow over outer walls defined by the membrane removing oxygen therefrom as is recited in claim 29.

In the office action, the Examiner states that positioning the ion transport membrane into a fluidized bed would constitute a clean environment "since the bed material would not penetrate the ion transport membrane." Such an interpretation runs afoul of the definition of "clean" set

forth in Prasad, e.g. an environment that does "not contain any species detrimental to the ion transport membrane." (Prasad col. 15, ll 22-3). The fact that solids do not penetrate the membrane is not part of Prasad's definition. Where, as is the case here, when a term in a patent is clearly defined, that is the interpretation that must be applied. The Examiner could only have arrived at his definition of "clean" based on hindsight, which is improper. For at least these reasons, Prasad teaches away from the invention recited in the claims of the application in question.

Based on the foregoing, one skilled in the art would not look to Prasad for guidance regarding placing an oxygen transport membrane into a fluidized bed forming part of a boiler. Prasad's definition of "clean" as well as the disclosure set forth above, would likely result in one skilled in the art concluding that exposing the membranes to hot solids would be detrimental thereto. Moreover, and as stated at page 3, lines 5-8 of the patent application as filed: "Since the heat exchange takes place with solids and not with gas, the membrane area necessary can be lower, which is essential for the compactness and economics of the technology." Accordingly, the membranes recited in Prasad, wherein heat transfer takes place with hot gas, would not be appropriate for use in the apparatus recited in the claims of the instant patent application.

For at least these reasons, Prasad does not teach or suggest the invention recited in claim 29 of the present patent application.

Anderson is directed to:

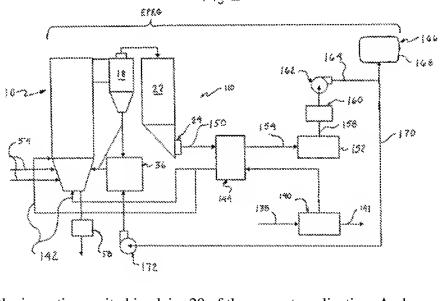
> A circulating fluidized bed steam generator 10 and a method for operating the circulating fluidized bed steam generator are provided which offer the flexibility to use carbon dioxide (CO_2) both as a desirable end product and as support to the combustion process. The method includes the step of introducing a substantially pure oxygen feed stream into the circulating fluidized bed steam generator 10 and the step of combusting a fuel in the presence of the substantially pure oxygen feed stream to produce a flue gas having carbon dioxide and water vapor as its two largest constituent elements by volume. The method also includes the step of passing the flue gas through an oxygen feed stream pre-heater 144 at which heat from the flue gas is transferred to the oxygen feed stream. Furthermore, the method includes the step of separating the flue gas into an end product portion

and a recycling portion. The method additionally includes cooling and compressing the end product portion of the flue gas so as to yield carbon dioxide in a liquid phase and directing the recycling portion of the flue gas to the circulating fluidized bed steam generator 10 to contribute to the combustion process therein. (See the Abstract of Anderson).

In the Office Action, the Examiner states that Anderson teaches; "a circulating fluidized bed boiler (10) having a firebox 12 in which solid fuel is combusted in the presence of oxygen to generate flue gases containing heated solids, a fluidized bed (36) containing the heated solid fluidized by the fluidization gas (Anderson has a separator 18 which separates out the heated solids which flow to the fluidized bed 36)." The Examiner goes on to state that "a person having ordinary skill in the art at the time the invention was made would have found it obvious to incorporate the teaching of Prasad et al. of the ion transport membrane (oxygen transport membrane) into the fluidized bed (36) of Anderson. . ."

In order to facilitate a better understanding of the characterizations made by the Examiner, FIG. 2 of Anderson is reproduced below.

Fig 2



Unlike the invention recited in claim 29 of the current application, Anderson does not teach or suggest a "circulating fluidized bed boiler comprising: a fire box in which solid fuel is combusted in the presence of oxygen to generate gases containing heated solids; a fluidized bed

containing the heated solids fluidized by a fluidization gas . . ." Instead, Anderson teaches a boiler 10 having a separate fluidized bed heat exchanger (FBHE) 36 in communication therewith. The FBHE does not form part of, and is wholly separate from the boiler 10. Accordingly, Anderson teaches away from a fluid bed boiler having, as part thereof, a fluidized bed containing the heated solids fluidized by a fluidization gas. Moreover, since element 36 of Anderson is a heat exchanger having a working fluid flowing therethrough (see col. 5, ll 4-8 of Anderson) to which heat from the hot solids is transferred, the cooler solids would be less effective at supplying heat to oxygen transport membranes if they were positioned therein as the Examiner suggests. Such a configuration would, if sufficient heat was transferred to the working fluid of Anderson, render any oxygen transport membranes positioned in the FBHE (as the Examiner suggests) ineffective. Accordingly, one of ordinary skill in the art would not look to Anderson for guidance in developing the claimed invention since the configuration of the system disclosed in Anderson runs counter to what would be needed to make the claimed invention operable.

Furthermore, one skilled in the art would not look to the combination of Prasad and Anderson for guidance. Prasad, for the reasons set forth above, teaches away from the invention, and discloses a membrane configuration for which the instant application seeks to avoid as being inefficient. Anderson, discloses an FBHE separate and apart from the boiler that is operable to transfer heat from hot solids to a working fluid thereby rendering the hot solids cooler and thereby less effective, or ineffective for purposes of heating the membranes so that oxygen can be generated.

Even if, Prasad and Anderson were combined as the Examiner suggests, the invention claimed in the present application would not be arrived at since the combination of references would result in ion transfer membranes configured to work only with hot gases being positioned in an FBHE wholly apart from the boiler wherein hot solids would have to transfer sufficient heat to a working fluid as well as the ion transfer membranes. This is not the invention recited in claim 29 of the instant patent application.

Regarding claim 49, the same reasoning with respect to the Prasad patent as applied to claim 29, applies to claim 49. With respect to Anderson, even if Prasad and Anderson were combined as the Examiner suggests, the invention recited in claim 49 of the present application

would not be arrived at since the combination of references would result in ion transfer membranes configured to work with hot gases being positioned in an FBHE wherein hot solids would have to transfer sufficient heat to a working fluid as well as the ion transfer membranes.

For at least the reasons set forth above, Applicants submit that independent claims 29 and 49 are patently distinguishable over the references applied by the Examiner. Since the remaining claims in the application all ultimately depend from either claims 29 or 49 they too are patentably distinguishable over the applied references.

Claims 36, 52 and 59 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Prasad in view of Anderson and further in view of United States Patent No. 6,532,905 to Belin (hereinafter Belin). Claim 52 was cancelled in the previous Office Action response. Claim 36 depends from claim 29 and claim 59 depends from claim 49 and therefore are patentable over the applied references for at least the reasons provided hereinbefore. It is respectfully requested that these claims be reconsidered and allowed.

Claim 37 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Prasad in view of Anderson and further in view of United States Patent No. 5,476,639 to Hyppanen (hereinafter Hyppanen). Claim 37 ultimately depends from claim 29 and therefore is patentable over the applied references for at least the reasons provided hereinbefore. It is respectfully requested that this claim be reconsidered and allowed.

Claims 38 and 51 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Prasad in view of Anderson and further in view of Hyppanen. Claim 38 ultimately depends from claim 29 and claim 51 depends from claim 49 and therefore are patentable over the applied references for at least the reasons provided hereinbefore. It is respectfully requested that these claims be reconsidered and allowed.

Claims 42 and 55 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Prasad in view of Anderson and further in view of United States Patent No. 5,284,583 to Rogut. Claim 42 ultimately depends from claim 29 and claim 55 depends from claim 49 and therefore are patentable over the applied references for at least the reasons provided hereinbefore. It is respectfully requested that these claims be reconsidered and allowed.

Claims 43-45 and 56 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Prasad in view of Anderson and further in view of United States Patent No. 7,125,528 to

Besecker et al. Claims 43-45 all ultimately depend from claim 29 and claim 56 depends from claim 49 and therefore are patentable over the applied references for at least the reasons provided hereinbefore. It is respectfully requested that these claims be reconsidered and allowed.

No other fees are believed to be due with the filing of this Amendment, other than the fee for the Request for Continued Examination and three-month Extension of Time. If any further fees are required, please charge them to Deposit Account No. 503342.

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